

Table 7

Spin Valve Film Constitution:

Substrate/5 nanometer Ta/NiFe/CoFe/3 nm Cu/2.5 nm
CoFe/antiferromagnetic layer/5 nanometer Ta

Antiferromagnetic Layer		J (erg/cm ²) at 200°C	H _{DA} (Oe) at 200°C	Blocking Temperat ure T _b (°C)	Resistan ce Change Rate $\Delta R/R$ (%)
Material	Thicknes s (nm)				
Ir22Mn78	5	0.04	170	250	6.6
	10	0.045	190	290	6.2
Pt51Mn49	10	0.03	130	300	7.2
	20	0.1	430	350	6.7
	30	0.12	510	370	6.4

Spin valve films with IrMn: heat-treated at 270°C for 1 hour.

Spin valve films with PtMn: heat-treated at 270°C for 10 hours.

Table 8

Antiferromagnetic Layer		Half-value Width of the diffractio n peak from the close- packed plane in its rocking curve, $\Delta\theta$	J (erg/cm ²) at 200°C	Blocking Temperatur e T _b (°C)
Material	Thickness (nm)			
Ir22Mn78	5	12	0.1	210
	5	8	0.025	230
	5	5	0.045	250
	5	3	0.05	250
Rh20Mn80	7	13.5	~0	190
	7	8	0.02	225
	7	4	0.025	235

As in Table 6 and Table 8, we, the present inventors have found that (1) when the pinned magnetic layer is coupled to the antiferromagnetic layer has a structure of SyAF and when the composition of the antiferromagnetic layer is specifically selected, then the magnetic coupling coefficient J at 200°C could be at least 0.02 erg/cm^2 , (2) when the close-packed plane of the antiferromagnetic layer is so oriented that the half-value width of the diffraction peak from the close-packed plane of the layer in its rocking curve is reduced, preferably so that it appears at 8 degree or smaller, more preferably at 5 degrees or smaller, then the magnetic coupling coefficient J at 200°C could be increased, (3) when the magnetic thickness of the antiferromagnetic layer is not larger than 20 nanometers, more preferably not larger than 10 nanometers, then the resistance change rate in the spin valve device having a multi-layered, pinned magnetic layer structure could be increased to be comparable to or higher than that in the spin valve device having a single-layered, pinned magnetic layer structure, and (4) when the magnetic coupling coefficient J at 200°C is at least 0.02 erg/cm^2 , then the magnetic coupling bias H_{UA}^* at 200°C could be at least 200 Oe, and, therefore, even though the maximum magnetic field to be applied to the reproduction device, spin valve film, from a recording medium or the like is 200 Oe, the pinned magnetic layer in the spin valve film is still kept stable. On the basis of these findings,

we have completed the present invention.

Fig. 18 is a schematic view of the magnetic coupling bias field H_{UA}^* versus the change in the resistance of the spin valve film depending on the applied magnetic field. In Fig. 18, the magnetic coupling bias field H_{UA}^* is defined as the maximum magnetic field at which the magnetization of the pinned magnetic layer does not substantially move, and this is obtained as the intersection of the extended line from the linear region in the low magnetic field side and the extended line from the linear region in the high magnetic field side. The magnetization of the pinned magnetic layer having a magnetic coupling bias field H_{UA}^* of at least 200 Oe moves little within the magnetic field range up to 200 Oe in the resistance-magnetic field characteristics for which an external magnetic field is applied to the magnetization pinned direction, and only the free layer responds to the magnetization to give resistance change.

In Fig. 18, seen is only the steep resistance change resulting from the magnetization response of the free layer in the vicinity of the magnetic field of zero which is the operating point for a magnetic field sensor, on the resistance-magnetic field characteristic curve. In this, no resistance change is admitted except the magnetization response of the free layer to the applied magnetic field of up to 200 Oe. After the free layer has been saturated, there